SUPPLEMENTATION OF WHEAT PASTURE

STOCKER CATTLE WITH SILAGE

By

MICHAEL JOSEPH FORD

Bachelor of Science

Purdue University

West Lafayette, Indiana

1981

Submitted to the Faculty of the Graduate College
of Oklahoma State University
in partial fulfillment of the requirements
for the Degree of
MASTER OF SCIENCE
May, 1984

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Thesis Approved:

[illegible]

Thesis Adviser

William A. Phillips

David L. Buchanan

Norman N. Durham

Dean of the Graduate College

ACKNOWLEDGEMENTS

I wish to thank Dr. Gerald Horn, my major advisor, for his advice in preparation of this manuscript and during the course of this study. Thanks to Drs. William Phillips and Dave Buchanan for their time spent as advisors on my committee. I also wish to thank Dr. Ronald McNew for assistance in statistical analysis of data.

Ann Worthington and her excellent crew of young men that assisted in all parts of this study have my appreciation. I would like to thank Donna Perry for her assistance and patience during laboratory analyses. Appreciation is also extended to David Pace, Steve Arp, and other fellow graduate students for their friendship during my stay in Stillwater.

Special thanks to my parents, Harold and Karen, for their infinite love and moral support. Further thanks to my wife's family for their support.

Finally, a very special thanks to my wife, Amy, for her encouragement, support, and love during the course of these studies.

TABLE OF CONTENTS

Chapter Page

LIST OF TABLES

Table Page

LIST OF FIGURES

Figure Page

CHAPTER I

INTRODUCTION

The need for developing pasture systems in the beef industry appears to occur in conjunction with the world demand on grain (Olentine, Jr. et al., 1976; Bowling et al., 1978). Energy supplementation of cattle grazing pasture is one such system. Three reasons exist for supplementing animals on pasture: First, to alleviate a shortage of herbage due to environmental influence; second, to improve the energy to protein ratio or the overall nutrient balance; third, to increase the carrying capacity of the pasture (Newton and Young, 1974). All three reasons indicate the need to increase individual animal performance, add stability to the feed supply or to increase animal production per unit of pasture.

Reports concerning the effects of supplemental feed are conflicting. Many researchers have reported that energy supplementation to steers grazing pasture can either improve animal performance (Perry et al., 1971; Forbes et al., 1966; Allden and Jennings, 1962) or not (Prescott and Hinks, 1968; Clanton et al., 1966; Alder et al., 1956). The best measure of the effectiveness of a management procedure in animal production is the change in productivity of the system in response to that procedure (Gulbransen, 1976).

Supplementing silage to wheat pasture stocker cattle may aid in increasing animal performance and add stability to the feed supply. However, high levels of supplementation may result in substitution of the supplement for herbage, thus creating a waste of the relative cheaper and more nutritious feed source, wheat forage, because less is eaten. Management decisions then involve making the maximum use of the wheat forage and minimum use of the more expensive supplement to produce an economical product.

The purpose of this study was to evaluate the effects of supplementing silage to wheat pasture stocker cattle on silage intake, average daily gain and wheat forage intake of the steers. The information reported herein are the findings of the first two years of a three year study that was initiated in the fall of 1981.

CHAPTER II

REVIEW OF LITERATURE

The Effects of Supplementation on Stocker Cattle Performance

Beef finishing operations often will lower their feed costs per kilogram of gain with the utilization of grazing systems. However, because forages lack nutrient balance or palatability or both, a definite conflict exists between the dual aims of achieving a high level of animal performance and a high efficiency of herbage utilization. Forages provide nearly 75% of the feed units consumed by all beef cattle (Hodgson, 1967). This literature review investigates the effects of supplementation on intake and utilization of forages, the stocking rate and beef production per unit of land area, and the performance of grazing animals on different types of pastures. The review concludes with procedures for estimating forage intake from rate of passage.

Supplementation on Pasture

Intake and Forage Utilization. Lake et al. (1974a) measured forage intake of steers that were either grazing irrigated pasture only (mixture of alfalfa, smooth bromegrass, and orchardgrass) or grazing irrigated pasture and supplemented with 1.36 kg of ground corn per head daily. These researchers observed no difference in daily fecal output or total feed intake (forage plus supplement) expressed as a percentage of body weight. They did observe a difference in forage intake when expressed as a percentage of body weight. The steers recieving corn consumed less forage than those grazing only (2.57 vs 2.89% $\pm$ .062, respectively) when intake was expressed as a percentage of body weight. The corn replaced about 15% of the diet dry matter and reduced forage intake by the same amount. Lake et al. (1974a) also studied forage intake and nitrogen utilization of steers fed either freshly clipped forage offered ad-libitum or freshly clipped forage plus either .45 or 1.36 kg ground corn per head daily. In this study these workers found no differences in the daily amounts of total (forage plus supplement) intake, forage intake, or fecal output (all expressed in kg of dry matter) among treatments. They did, however, see significant differences for the treatment recieving the clipped forage plus 1.36 kg ground corn on apparent dry matter digestibility and the grams of nitrogen retained daily. These workers concluded that the increase in nitrogen retention observed may have been due to the stimulation of microbial growth by the added energy therefore, converting more rumen ammonia to microbial protein. Because the freshly clipped forages had a high crude protein content (17.8%), the added energy served to narrow the protein to energy ratio by decreasing the forage protein intake and increasing the digestible energy content of the diet.

Lake et al. (1974b) reported their data when they supplemented steers grazing irrigated mixed grass-legume pastures of orchardgrass, smooth bromegrass, and alfalfa with either ground corn or a corn molasses dehy pellet. These researchers provided ground corn at levels of 0.0, 0.22, 0.45, 0.90 and 1.80 kilograms per-head daily in Experiment One and a corn-molasses-dehy pellet at levels of 0.0, 0.45, 0.96, 1.35, 1.80, 2.25 and 2.70 kilograms per head daily in Experiment Two to the steers. They monitored blood urea nitrogen (BUN) levels as an indication of nitrogen utilization in the ruminant. The BUN levels, taken four hours after feeding, in experiment one tended to decrease with increased energy supplementation, but these changes were not significantly different. However, Lewis et al. (1957) indicated that BUN levels change 4-6 hrs. after the rumen ammonia levels change. Thus, the early sampling time in experiment one may be the reason for no differences seen in the BUN levels. In experiment two the samples were taken 5-6 hrs. after supplementation. As energy supplementation increased, BUN levels were significantly decreased. They also reported that in both experiments urinary creatinine nitrogen ratios (Cr/N) indicated nitrogen excretion in the urine. Their Cr/N ratios for both experiments increased linearly as supplemental energy intake increased. Their conclusions as to the relationship of BUN levels to Cr/N ratios were that either the increased intake of a low protein-high energy supplement may have decreased the high protein forage intake, or that widening of the protein to energy ratio with supplemental energy may increase nitrogen utilization. The first conclusion agrees with their previous work (Lake et al., 1974a), and they cited Forbes et al. (1966) in support of their second conclusion.

Lonsdale et al. (1971) reported the effects of feeding dried S24 perennial ryegrass alone or with barley supplementation on feed intake of steers. These workers found that inclusion of barley increased the in vivo dry matter digestibility of both the dry matter and the organic matter of the diet but decreased the in vivo dry matter digestibility of the dietary cellulose. Their data also showed no difference in the total organic matter intakes among the treatments.

Vadiveloo and Holmes (1979) fed steers that grazed pastures of mixed varieties of ryegrass 7-8 g of a primarily rolled barley supplement per kg of liveweight to study its effect on intake and digestibility. They reported the herbage organic matter intakes of the steers were depressed by an average of 18.5%, but the total organic matter intakes were increased by an average of 12%. They concluded that in good grazing conditions the negative effect of supplemental feeding on herbage intake is partially offset by an increase in organic matter intake. They also concluded that a barley supplement is highly digestible in the ruminant, and this may also reduce cellulose digestion.

Amos and Evans (1976) used cannulated (ruminal and abomasal) mature wethers to study the effects of different protein supplements in combination with low quality bermudagrass on the amounts of protein synthesized by rumen microbes. They observed microbial protein synthesis increases with the addition of sunflower protein but the addition of urea had no effect on microbial protein synthesis. They concluded that efficient utilization of protein in ruminants fed low quality roughage diets depends on the type of protein supplemented.

The combination of grain supplementation and grass pastures may or may not result in an increase in the total dry matter or organic matter intake. When supplementary grain is fed, the shift in intake is often small. This is because the cattle are substituting the supplemented grain for forage (Blaxter and Wilson, 1963; Holmes and Jones, 1964). Although supplementation with concentrates can depress forage intake and cellulose digestion, nitrogen utilization may be increased by narrowing the protein to energy ratio.

Stocking Rate and Beef Production per Unit of Land Area. The performance response of steers to stocking rate is greater when the hergage mass is low (Wolfe et al., 1980). Steers grazing leucerne or leucerne-clover pastures had similar gains whether the stocking rate of steers was 1.3 or 2.0 steers per hectare (Wolfe et al., 1980). When the stocking rate was increased from 2.0 to 3.0 steers per hectare, individual gains decreased by 35 to 40 kg. However, the amount of total beef produced per hectare was increased by nearly 8%. When Wolfe et al. (1980) supplemented approximately 2.0 kg oat grain per head daily on the 3.0 steers per hectare stocking rate they observed no differnce in the liveweight gains when compared to the 2.0 steers per hectare treatment.

Hamilton and Madden (1977) increased total beef produced per hectare of legume pastures by nearly 10% by increasing the stocking rate by one steer per hectare. However, total gain per head was decreased by 45 kilograms.

Tayler and Wilkinson (1972) compared the performance of steers at two stocking rates (4 or 6 steers/ha) on S24 perennial ryegrass pasture and had either no supplement, ad-libitum supplementation (85% corn and 15% protein concentrate), or 50% of the ad-libitum group. The higher stocking rate plus ad libitum supplementation produced nearly 54% more beef per hectare than the low stocking rate and ad libitum supplementation. The 50% and ad libitum supplemental groups performed 36 and 60 percent greater than those steers of the unsupplemented group.

Wise et al. (1967) supplemented steers grazing bermudagrass at various stocking rates (0.91, 1.02, 1.14 or 1.25 steers/ha) with either no supplement, an energy supplement (ground corn plus 10% animal fat), a protein supplement (soybean meal, SBM), or a combination energy-protein supplement (80% corn, 10% SBM, and 10% animal fat). Supplemental feeding increased the amount of beef produced per hectare when both the low and high stocking rates were allowed access to supplemental feed. The effect of supplementation was more dramatic at the higher stocking rate than the lower. Supplemental feeding increased kilograms of beef per hectare by 40 and 150 percent at the lower (.91 steers/ha) and the higher (0.25 steers/ha) stocking rates, respectively. Perry et al. (1971) used one stocking rate and varied the level of supplementation. Cattle fed greater amounts of concentrates on pasture gained more rapidly than cattle fed lesser amounts of concentrates. Thus, the carrying capacity of a pasture and the amount of beef production per of unit land area can be increased from 50 to 150% with supplementation.

Animal Performance. Many researchers have reported data concerning gains of animals grazing pasture with and without supplementation. Potter et al. (1976) reported a 17% improvement in gain and a 20% improvement in feed efficiency when steers grazing grass-legume pastures were fed 200mg monensin per head daily in a corn-soy based supplement as compared to no supplementation. Morgan and Saul (1976) used a stocking rate of 5 steers per hectare on hay aftermath to evaluate no supplement versus supplementation with linseed meal, hay, linseed meal and hay, oats, oats and hay, oats and linseed meal, and oats linseed meal and hay. Daily gains for these steers were 0.24, 0.31, 0.43, 0.63, 0.60, 0.73, 0.97 and 1.01 kilograms, respectively. In all cases daily gains of steers were higher when supplementation was offered than when no supplement eas fed. Wise et al. (1967) used both a varied stocking rate and various supplements to evaluate the impact of energy and/or protein on steer performance. These data were as follows:

TABLE I

AVERAGE DAILY GAINS AND FEED CONVERSION RATIOS OF STEERS FED VARIOUS SUPPLEMENTAL FEEDS (WISE ET AL., 1967).

	Average Daily Gains (Kg)				Supplement Feed:Gain	
Steers/acre	Pasture	Pasture + Prot.	Pasture + Ener.	Pasture Prot. & Ener.	Ener.	Energy& Protein
0.91	0.60	0.70	0.84	0.85	1.93	1.98
1.02	0.52	0.62	0.96	0.95	2.19	2.37
1.14	0.46	0.51	0.94	1.06	2.77	2.44
1.25	0.50	0.70	1.19	1.27	2.24	1.91

In this study the feed to gain ratios were calculated by taking the daily feed intake and dividing by the average daily gain. Providing energy to steers at any of the four stocking rates increased daily gains more then the protein supplement, but at the higher stocking rates the effects of protein and energy appear to be additive.

Supplementation on Small Grain and Higher Quality Pastures

Intake and Forage Utilization. Supplementation on small grains pastures has recently generated a great deal of interest, there is not a large amount of data available from which to make sound management decisions. Utley et al. (1973) assigned steers to treatments of either oat or rye pasture with no supplemental feed, oat or rye pastures with supplemental feed (ad libitum corn silage), or corn silage and cottonseed meal only. The small grains pastures had a very high crude protein content (20%) when the forage was growing very rapidly, but the crude protein content decreased (11%) as the forage matured. Even at the lowest crude protein levels, the forage contained enough crude protein to meet the requirement of a 350 kg steer to gain .91 kg./day (NRC, 1976). Steers fed corn silage plus small grain pasture consumed one-third as much silage as steers in drylot when allowed two-thirds as much grazing as steers in the grazing only group.

Umoh and Holmes (1974) studied the forage intakes of steers grazing perennial ryegrass and white clover pastures when offered no supplement, cane molasses, molassed sugar-beet pulp, or barley straw. The molasses supplement increased total organic matter intake by .67 kg for each kg of supplement consumed and the sugar-beet pulp supplement increased total organic matter intake by .48 kg for each kilogram of supplement consumed. They concluded that, as supplement intake increased, the forage intake decreased. The straw supplement had no effect on intake.

Mader (1981) estimated wheat forage intake and utilization when steers were allowed to graze wheat pasture and fed a supplement of low quality roughage (wheat straw or sorghum-sudan hay). The rate of passage was used to estimated forage intakes and utilization of the steers. The data suggested that wheat forage intakes are identical whether a supplement was offered or not. However, the feeding of low quality roughage supplement tended to increase turnover rate and decrease rentention time of the wheat forage in the rumen. Thus increasing the passage rate. He concluded that the low quality roughage was occupying space in the rumen thus decreasing the available space for wheat forage. However, the addition of low quality forage did not effect the utilization of wheat forage among his treatment groups.

Gulbransen (1976) fed rolled milo to steers which were grazing oat pastures at various stocking rates (.4-.08 ha/hd). The grain consumption increased as the stocking rate increased, but the forage intake was not measured.

Utley and McCormick (1976) reported results of studies in which steers grazed rye pastures with either free access to whole shelled corn or rolled grain sorghum supplements. They observed that steers receiving corn or sorghum supplements consumed 5.86 and 5.91 kg. of grain per head daily, respectively. Although forage intakes were not reported, it was concluded that supplemental corn was a more efficient energy source for steers as compared to sorghum when grazing small grain pastures (Table II).

Elder (1967) reported data he collected over a three year period to study the performance of steers for different small grain pastures. A grain supplement was also offered. Steers had a preference for oat pasture followed by rye, wheat and barley pastures. Grain consumption averaged 2.5 kg./hd daily when supplement was offered with the pasture.

In the above studies, the effect of supplementation on nitrogen retention and excretion has been addressed by few researchers. However, in a review paper, Clanton (1977) suggests that when the protein to energy ratio is large intake may be limited due to inadequate quantities of available energy. Small grains pastures are high in crude protein and are very digestible (Utley et al., 1973; Mader and Horn, 1980; Horn et al., 1981). When protein is present in excess amounts, it is deaminated for utilization as energy and the nitrogen has to be eliminated from the system, which requires the expenditure of energy (Clanton, 1977). However, if the nitrogen from the forage protein is extremely soluble it can pass through the system and be expelled without alot of energy.

TABLE II

PERFORMANCE OF STEERS FED CORN OR GRAIN SORGHUM ON RYE PASTURE (UTLEY AND McCORMICK, 1976).

Item	Grazing only	Grain Sorghum	Corn
No. of Steers	18	18	18
Initial wt., kg	322	320	320
Final wt., kg	431	458	460
Ave. daily gain, kg	1.06a	1.35b	1.36b
Daily supp./head, kg	0	5.91	5.85
Rye pasture/head, ha	0.53	0.27	0.27

abc Means in the same row with a common letter are not different (P>.05).

Stocking Rate and Beef Production per Unit of Land Area. Bertrand and Dunavin (1977) presented data in which the amount of grain supplemented to steers on mixed rye-clover pastures was varied. Stocking rate and total beef production per hectare were increased as the amount of grain supplemention increased. The stocking rates increased from 4.09 steers per hectare for the treatment with no supplementation to 5.32 steers per hectare for the treatment recieving 1.5% of the animal's body weight in supplemental feed dry matter daily. It was also reported that beef production increase by 354 kg per hectare when supplemental feed was offered. This increase was nearly 61% over that observed for the unsupplemented group. Supplementation also resulted in an increase of 30% (39 days) for the number of animal grazing days per hectare.

Hodgson and Tayler (1972) grazed steers on high quality S321 perennial reygrass and provided kibbled barley of 0.0, 0.75, or 1.50 percent of body weight per head daily. They reported that supplementation at 1.5% would support an increase in the stocking rate of 36% over the non-supplemented group and increased the beef production per unit land area grazed (liveweight gain) nearly 63%. Elder (1967) reported an increase of 60 kilograms of gain per hectare by supplementation and total beef produced per hectare increased.

Although Utley and McCormick (1976) reported no differences in the grain consumption of steers supplemented while grazing rye pastures, they did observe a difference in the potential stocking rate. When no supplement was offered, 0.59 hectares of rye pasture were required per steer, but when a corn or sorghum grain was offered to the steers the hectare requirment decreased to 0.27 hectares of rye pasture per steer. They also observed significant increases in gain when supplement was offered which in combination with increased stocking rate will generate more total beef produced per hectare.

Utley et al. (1973) reported no differences in the amount of carcass weight produced for either of the pasture only treatments or pasture plus supplementation treatments. However, the oat or rye pasture plus corn silage treatment required a stocking rate of 0.26 hectares per steer while the oat or rye pasture only treatments required 0.45 hectares per steer.

From the above studies it can be concluded that energy supplementation of steers on small grain pastures can result in an increase in the number of grazing days per unit land area, stocking rate, and total beef production per unit land area.

Animal Performance. Utley and McCormick (1976) consistently observed increases in average daily gain of nearly 35% when corn or grain sorghum was used as a supplement to steers grazing on small grain pastures. Utley et al. (1973) saw no significant increases in average daily gains when corn silage was fed to steers grazing rye pastures. Mader (1981), when feeding low quality roughages to steers on wheat pasture, observed no significant differences in the average daily gains of the steers. Gulbransen (1976) observed that carcass gains per hectare increased by .097 kg for each kg of supplement dry matter consumed when steers were grazing oat pasture in addition to sorghum grain being offered. Elder (1967) supplemented cattle grazing small grain pastures with corn or grain sorghum and oberved that average daily gains were increased by .15 kg per head over cattle grazing small grain pastures only. It was calculated that 4.27 kg of supplemental grain were needed for each additional kg of gain.

From these studies one can conclude that supplementation on small grain pastures will in most cases increase animal performance, when the supplement is a grain. However, to properly estimate the feed conversion efficiency for the increase in gain over that of pasture alone, the amount of forage consumed must be known. As was previously discussed, more research needs to be conducted before concrete conclusions as to what effect supplementation on small grain pastures will have on the efficiency of grain and forage utilization.

Estimating Forage Intake from Rate of Passage Studies

The forage intakes of grazing steers can be estimated if the fecal output is known. Fecal output can be estimated by rate of passage (Ellis et al., 1979). Ellis et al. (1979) concluded that for mathematical methods to be appropriately used, one needs to consider the flow of ingesta as a multicompartment process. It was proposed that a rare earth element be used as a marker by attaching it to the indigestible portion of feed. Ellis et al. (1979) suggested that less than 4% of the rare earth will be absorbed from the gut, and that it would simulate flow of residues throughout the digestive tract even at low concentrations. This simulation of flow was best seen if the concentration of the rare earth marker was between 15 and 25 mg/g for forages and between 1 and 4 mg/g for grains (Ellis et al., 1979).

After administering the labled feed in a single pulse dose, the concentration of marker in the feces can be plotted over time. This plot requires 10 to 15 fecal samples collected post dosing. Ellis et al. (1979) proposed the fecal excretion curve is best represented by a two compartment, sequential time dependent-time independent model. The equation for the time dependent-time independent model is as follows:

$$Y = K_0 e^{-k_1(t-\tau)} \left(\frac{k_1^2(t-\tau)}{k_2-k_1} - \frac{k_1^2}{(k_2-k_1)^2} \right) + K_0 e^{-k_2(t-\tau)} \left(\frac{k_1}{k_2-k_1} \right)^2 \qquad t > T$$

$$Y = 0 \qquad t \leq T$$

where Y is equal to the fecal marker concentration; K_0 is the initial concentration of marker in the independent compartment; k_1 is the time dependent rate constant; t is the time post dosage of marker; and τ is the time of first appearance of marker in feces.

Mader (1981) and Ellis et al. (1979) concluded that this model provides a superior fit of data points and an estimation of daily fecal output than did previously proposed models. In a study reported by Mader (1981) the Ellis et al. (1979) model was found to have a better fecal excretion curve fit and, on the average, estimated fecal output more closly than a two-compartment time-independent model (Grovum and Williams, 1973).

A two compartment model works fine when the rate of passage of digesta was slow enough (eg. lower quality-slower growing forages) for the rate constants of each compartment to be differentiated. However, if the rate of passage was fast (eg. high quality-rapidly growing forages) then there is little or no differentiation of the rate constants and a one compartment model can be used (McCollum, 1983a). The one compartment model equation as presented by Ellis et al. (1979) is as follows:

$$Y = K_0 * e^{-kt}$$

where Y is equal to the fecal marker concentration; K_0 is the initial concentration of marker in the compartment; k is the rate constant; and t is the time post dosage of marker. This model represents an exponential turnover rate in the compartment and may underestimate the actual turnover rate. This would give an erroneous estimate for the initial concentration of the marker (Ellis et al., 1979).

A more recently developed one compartment model incorporates age dependency as discussed by McCollum (1983b) (Pond et al., 1982). McCollum (1983b) reported that the one compartment model is preferred because it provides a better fit (lower error mean squares) for a wider variety of data sets.

The estimates of daily fecal output and forage intake with the two compartment model are calculated as follows:

GI Tract Fill of Undigested Dry Matter (UDMG),g =
Amount of Marker Administered,g $\div$ K_0

Daily Fecal Output (FO), kg =
(UDMG * k_1/hour * 24 hours) $\div$ 1000

Corrected FO (CFO), kg =
FO -- [kg Daily Supp. * (1 -- IVDMD of Supp.)]

Estimated Forage Intake, kg =
CFO $\div$ (1 -- IVDMD of Forage Grazed)

The estimation of forage intake for the one compartment model is calculated as the estimation of forage intake for the two compartment model was with the following differences:

UDMG, g =
Amount of Marker Administered,g $\div$ (K_0 * k * .59635)

FO, kg/day =
[(Amount of Marker Administered,g $\div$ K_0) * 24] $\div$ 1000

OR

FO, kg/day = UDMG * k * .59635 * 24

CHAPTER III

EFFECT OF SILAGE SUPPLEMENTATION OF WHEAT PASTURE STOCKER CATTLE ON SILAGE INTAKE AND CATTLE PERFORMANCE

Summary

In year 1 of the study 96 fall-weaned steer calves grazed wheat pasture and were fed no supplemental feed (treatment 1) or were fed silage (treatments 2,3 and 4) in amounts slightly in excess of what they would consume daily. Stocking rates were about 0.81, 0.80, 0.61 and 0.40 hectares per steer for treatments 1 through 4, respectively. In year 2 of the study 48 fall-weaned steer calves grazed wheat pasture and were assigned to treatments as in year 1. Stocking rates for year 2 were 1.25, 1.01, 0.78 and 0.94 hectares per steer for treatments 1 through 4, respectively. Mean daily silage DM intakes of steers of treatments 2, 3 and 4 (year 1) were 0.80, 1.49 and 2.12 kg, respectively. Average daily gains of steers in year 1 were 0.93, 0.92, 0.82 and 0.70 kg for treatments 1 through 4, respectively. Mean daily silage DM intakes of steers of treatments 2, 3 and 4 (year 2) were 1.04, 1.15 and 1.03 kg, respectively. Average daily gains of steers in year 2 were 0.96, 1.17, 1.05 and 1.00 kg for treatments 1 through 4, respectively. Steers of treatments 3 and 4 in year 1 had very low forage availabilities and compensated by consuming larger amounts of silage DM. In year 2, forage availability was very high and may

explain why values for each treatment were similar. From these studies it appears silage may have some benefit as a supplemental feed if forage availability is limited.

Introduction

Average daily gain is one of the key figures that affects the profitability of stocker cattle enterprises. Wheat forage has a high crude protein content and a high in vitro dry matter digestibility (25-32 and 68-75 %, respectively) (Johnson et al., 1973; Horn et al., 1981). Gains of stocker cattle grazing wheat pasture are potentially good. However, these gains are frequently reduced because of inadequate amounts of available wheat forage due to not enough forage growth or snow and ice cover. Therefore, developing feeding programs for wheat pasture stocker enterprises has the potential of increasing the amount of beef production from each hectare of wheat pasture and adding stability to the production system.

Frequently, producers find it more profitable to graze-out their wheat rather than harvest a grain crop. Only about 27% of the area needed during the fall and winter grazing period is needed for the graze-out period, assuming 1.01 and 0.27 hectares of wheat pasture will provide enough forage for a 182 kg steer from November 15 to March 15 and the subsequent graze-out period, respectively. Stocker operators who elect to carry cattle through a graze-out program would need to either purchase additional cattle or be able to carry more cattle during the November 15 to March 15 grazing period. One approach to this situation would be to feed silage to the cattle on wheat pasture during the fall and winter grazing period and increase the stocking rate. Feeding silage to wheat pasture stocker cattle would also have the advantage of having feed available during periods of snow or ice cover.

A project was begun in the fall of 1981 to determine the effects of feeding silage to wheat pasture stocker cattle on silage intake and average daily gain during the fall and winter grazing period. Data from the first two years of the three year project are reported herein.

Experimental Procedure

Wheat Pasture Year 1

Fifty-six Hereford and 40 Brahman crossbred (1/4 Brahman and 3/4 Hereford and Angus) fall weaned steers with mean weights of 168 and 243 kg, respectively, were randomly allotted (within breed) to four treatments of 24 steers each in a randomized complete block design with two blocks of wheat pasture. Treatments were as follows:

	TREATMENT			
	1	2	3	4
Silage:	−	+	+	+
Ha. Wheat Past/Steer:	0.81	0.81	0.61	0.40

During December 2, 1981 to March 15, 1982, steers of treatments 2,3 and 4 were fed wheat silage (harvested in the soft dough stage of maturity) slightly in excess of amounts that they would consume daily. Silage was not fed during the March 26 to May 20, 1982 graze-out period. Steers of all treatments grazed a single wheat pasture within a block at a stocking rate of 0.24 hectares per steer for the graze-out period.

Hay (old world bluestem) was fed to steers of treatment 1 during periods of snow and ice cover. Because of the mild winter, hay was fed only one day (Feb. 9, 1982).

Initial, intermittant and final shrunk live weights (after over night stand without feed or water) of the steers were measured to coincide with major changes in climatic growing conditions for the wheat pasture.

Silage consumption was measured daily for each treatment and samples were taken weekly and pooled across weeks within months for crude protein (macro-Kjeldahl procedure) and in vitro dry matter digestability (Tilly & Terry, 1963) determinations.

Available wheat forage of all pastures was estimated by hand-clipping three randomly selected 1/2 square meter plots of each pasture four times during the fall and winter grazing period. Terminal end clippings were also taken and analyzed for crude protein and IVDMD. Regrowth of wheat forage was calculated using the cage and strip method as described by Cook (1964).

All data were statistically analyzed using the General Linear Models (GLM) procedure in the Statistical Analysis System (SAS). Duncan's Multiple Range tests were used to analyze differences among treatment means.

Wheat Pasture Year 2

Twenty-eight fall weaned Hereford and 20 Angus steers with mean weights of 188 and 226 kg, respectively, were randomly allotted (within breed) to four treatments of 12 steers each in a randomized complete block design. Only one block of wheat pasture was used because of poor growing conditions. Treatments were as follows:

	TREATMENTS			
	1	2	3	4
Silage:	-	+	+	+
Ha. Wheat Past/Steer:	1.25	1.01	.94/.78	0.94

On February 17, 1983, steers of treatment 3 had their pasture decreased from .94 Ha/steer to .78 Ha/steer because a large area of the pasture was void of forage.

Cattle were cared for as described in year 1 with the following differences: 1) Sorghum silage was used in place of wheat silage, 2) the grazing period was from Jan. 13 to March 17, 1983, 3) hay (old world bluestem) was fed nine days to steers of treatment 1 because of snow and ice accumulations (Jan. 19 & 25; Feb. 1,3,4,5,6,7 & 10) When the hay was fed the steers consumed an average of 1.62 kg per head daily.

Samples and data were collected and analyzed as in year 1 with the following differences: 1) Availabilties of wheat forage were estimated by hand-clipping five randomly selected 1/2 square meter plots of each pasture three times during the grazing period and 2) Because there was no replication of treatments, statistical analyses of data could not be performed. After year 3 of the project, data of all years will be combined and analyzed.

Results and Discussion

Wheat Pasture Year 1

Silage consumption and amounts of available wheat forage during the period of feeding wheat silage on wheat pasture are shown in figures 1 and 2, respectively. Daily consumption of steers of treatments 2,3 and 4 was about 1.14 kg dry matter per head through the week of January 18. Consumption of silage by steers of treatments 3 and 4 increased markedly during the week of February 8 when available wheat forage was only about 200 and 34.1 kg dry matter per head on February 8. These forage availabilities are equivelent to about 329 and 84.3 kg dry matter per hectare for treatments 3 and 4, respectively. These amounts of available wheat forage are very low. For perspective, 15 centimeter tall wheat forage, planted on 31 centimeter row spacings, will yield about 562 kg of forage dry matter per hectare.

Treatment means of silage consumption (Table III) from period I (Dec. 2) to period II (Feb. 12) were not different with the exception of treatments 2 and 4 during weeks 1 to 7 (P>.05). However, treatment means of silage consumption in periods 3 (Feb. 12-Mar. 25) and IV (Dec. 2-Mar. 25) were different (P<.05). The extremely low forage availabilities during this latter period contributed to the higher silage intakes of steers of treatments 3 and 4. Wheat silage composition and wheat forage availability and composition are presented in appendix tables VI and VII, respectively.

Gains of the steers are shown in table IV. Steer gains for treatments 1 and 2 were similar during the December to March grazing period, whereas, daily gains of treatment 3 steers were 0.1 kg less and daily gains of treatment 4 steers were 0.23 kg less than those of treatment 1 and 2 steers. The decreased gains of treatment 4 steers were partially attributed to the extremely low wheat forage availabilities (i.e. about 10 % of treatment 2) during the late January to March grazing period (periods II and III). Gains of steers of all treatments were similar during the graze-out period (period IV).

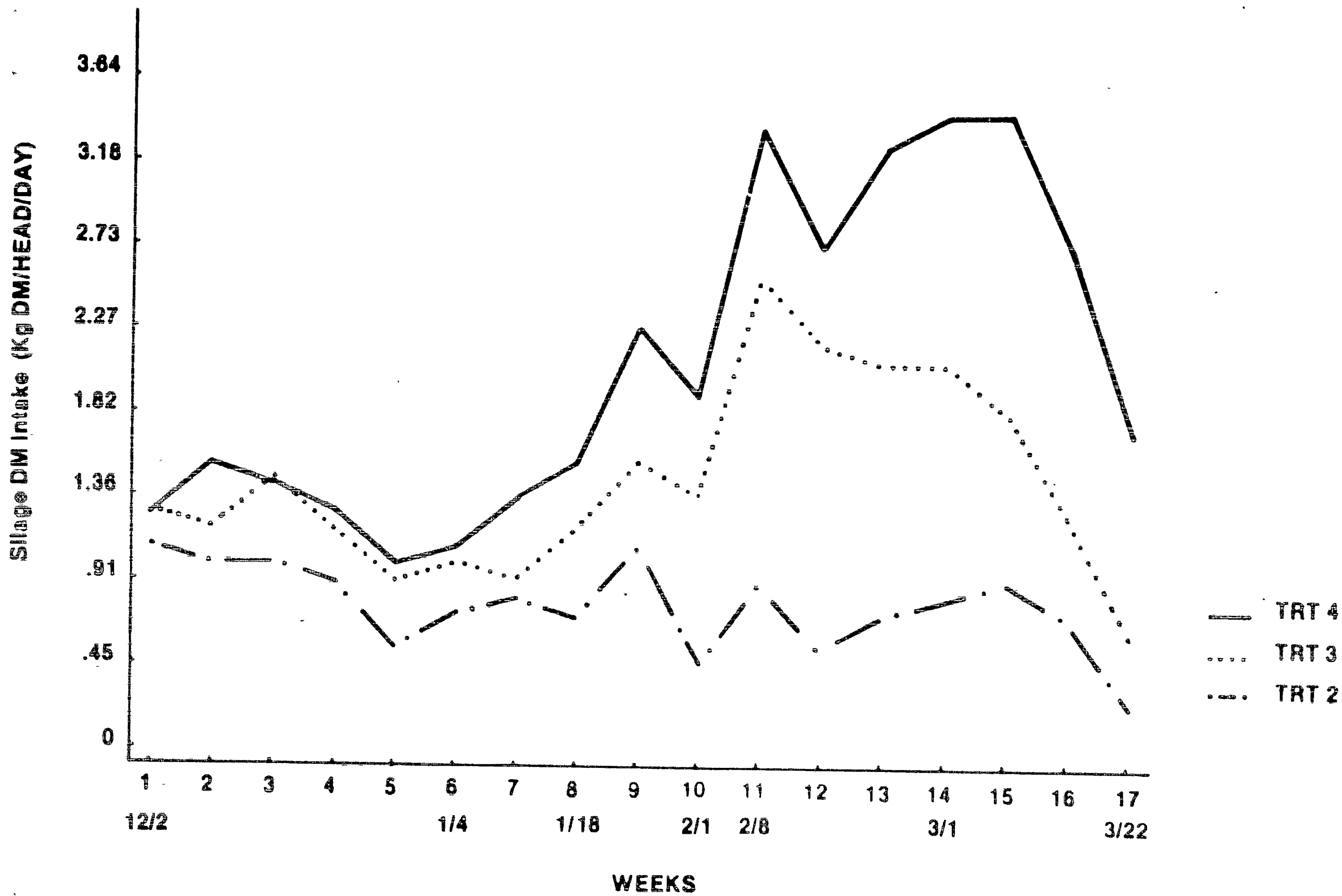

Figure 1. Silage Consumption (kg DM/Steer/Day) of Steers on Wheat Pasture Year 1.

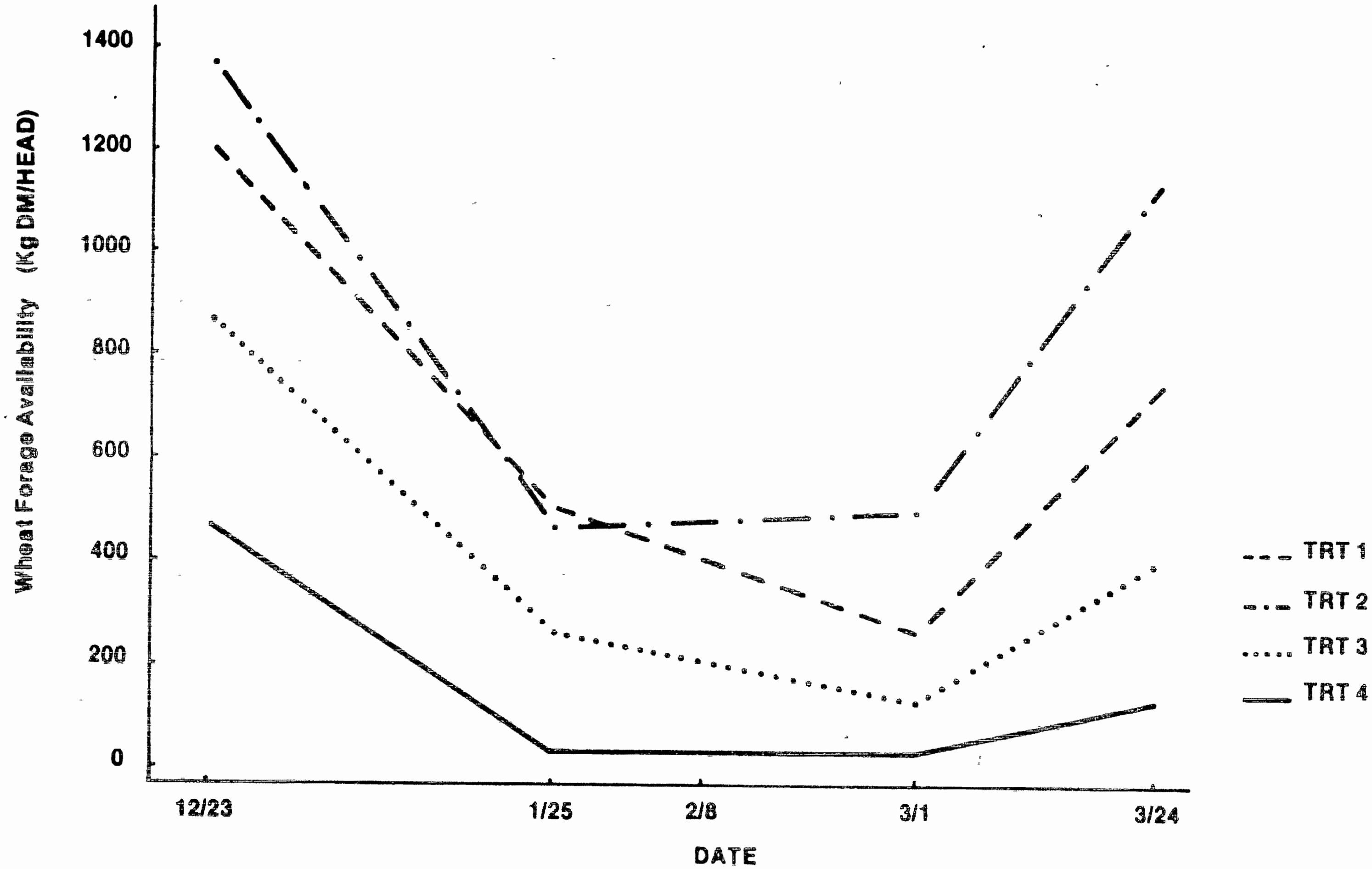

Figure 2. Wheat Forage Availability (kg DM/Steer) on Wheat Pasture Year 1.

TABLE III

SILAGE CONSUMPTION OF STEERS ON WHEAT PASTURE (YEAR 1)

		Treatment			
		2	3	4	SEM
Period	Date	kg DM/Steer			
I	12/2/81-1/14/82 (43 days)	0.88^{A}	1.13^{AB}	1.30^{B}	0.55
II	1/14/82-2/12/82 (29 days)	0.80^{A}	1.50^{A}	2.10^{A}	.244
III	2/12/82-3/25/82 (41 days)	0.72^{A}	1.80^{B}	2.95^{C}	.061
IV	12/2/81-3/25/82 (113 days)	0.79^{A}	1.45^{B}	2.09^{C}	.094

ABC Means in the same row with a common superscript are not different ($P>.05$).

TABLE IV

AVERAGE DAILY GAINS (kg) OF STEERS ON WHEAT PASTURE (YEAR 1)

Treatment:		1	2	3	4	
Number of Steers:		24	23*	23*	24	SEM
Period	Date					
I	12/2/81-1/14/82 (43 days)	0.81^{A}	0.70^{A}	0.78^{A}	0.83^{A}	.193
II	12/14/82-2/12/82 (29 days)	0.95^{A}	0.89^{A}	0.95^{A}	0.66^{B}	.139
III	2/12/82-3/25/82 (41 days)	1.04^{C}	1.17^{C}	0.78^{CD}	0.58^{D}	.215
1-III	12/2/82-3/25/82 (113 days)	0.93^{C}	0.92^{C}	0.82^{CD}	0.70^{D}	.110
IV	3/26/82-5/21/82 (57 days)					
	Graze-out	0.89^{A}	0.87^{A}	0.95^{A}	1.00^{A}	.152

* One steer died of respiratory disease at the beginning of the trial.

AB Means in the same row with a common superscript are not different (P>.05).

CD Means in the same row with a common superscript are not different (P>.10).

Wheat Pasture Year 2

Silage consumption and amounts of available wheat forage are shown in figures 3 and 4, respectively. Daily silage consumption of steers of treatments 2, 3 and 4 were 1.04, 1.15 and 1.03 kg dry matter per head for the 62 day grazing period (table V). Estimates of wheat forage availability on January 13, 1983 were 545, 764, 493 and 288 kg dry matter per steer for treatments 1 through 4, respectively. Forage availabilities increased during the grazing period to 1482, 1388, 1060 and 960 kg dry matter per steer for treatments 1 through 4, respectively, on March 17, 1983. However, it appeared that as wheat forage availability increased the overall silage consumption of steers tended to decrease. Sorghum silage composition and wheat forage availabilities and composition are presented in appendix tables VI and VIII, respectively.

Gains of steers on wheat pasture are presented in table V. Gains of steers of all treatments were quite similar. This may be due partially to the large amounts of forage that were available during the grazing period.

From these studies it appears that silage may help to maintain gain during periods of low forage availability as seen with treatment 4 in year 1. However, when forage is abundant (year 2), silage does not appear to increase animal performance. Because steer numbers used in these two years are low, the benefit obtained from silage supplementation is not substantiated and more studies are needed.

Although the gains of treatment four, year one steers were 0.23 kg lower than treatment one, the stocking rate was twice that of treatment one. Thus, production per unit was 1.4 kg for treatment four and only 0.9 kg for treatment one.

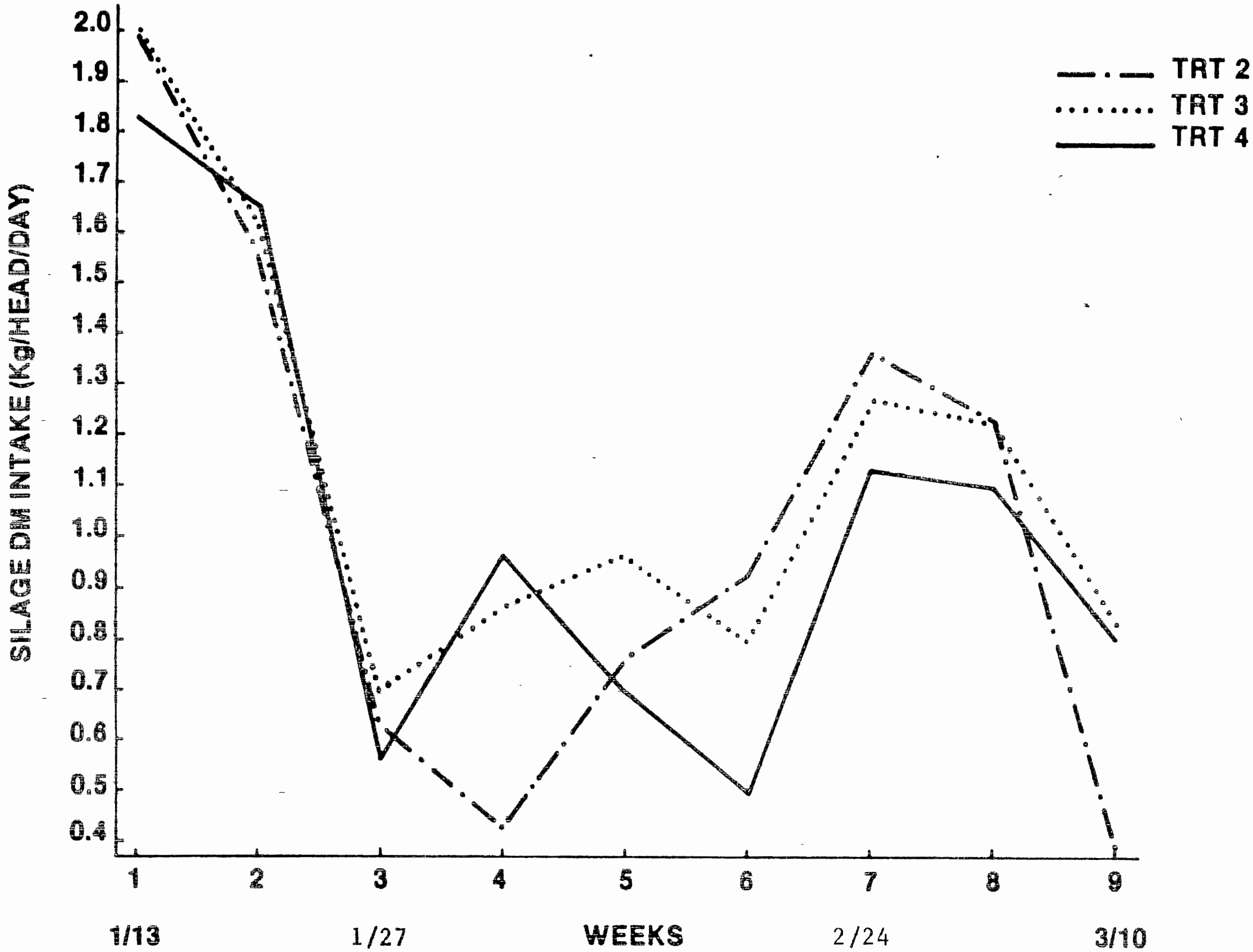

Figure 3. Silage Consumption (kg DM/Steer/Day) of Steers on Wheat Pasture Year 2.

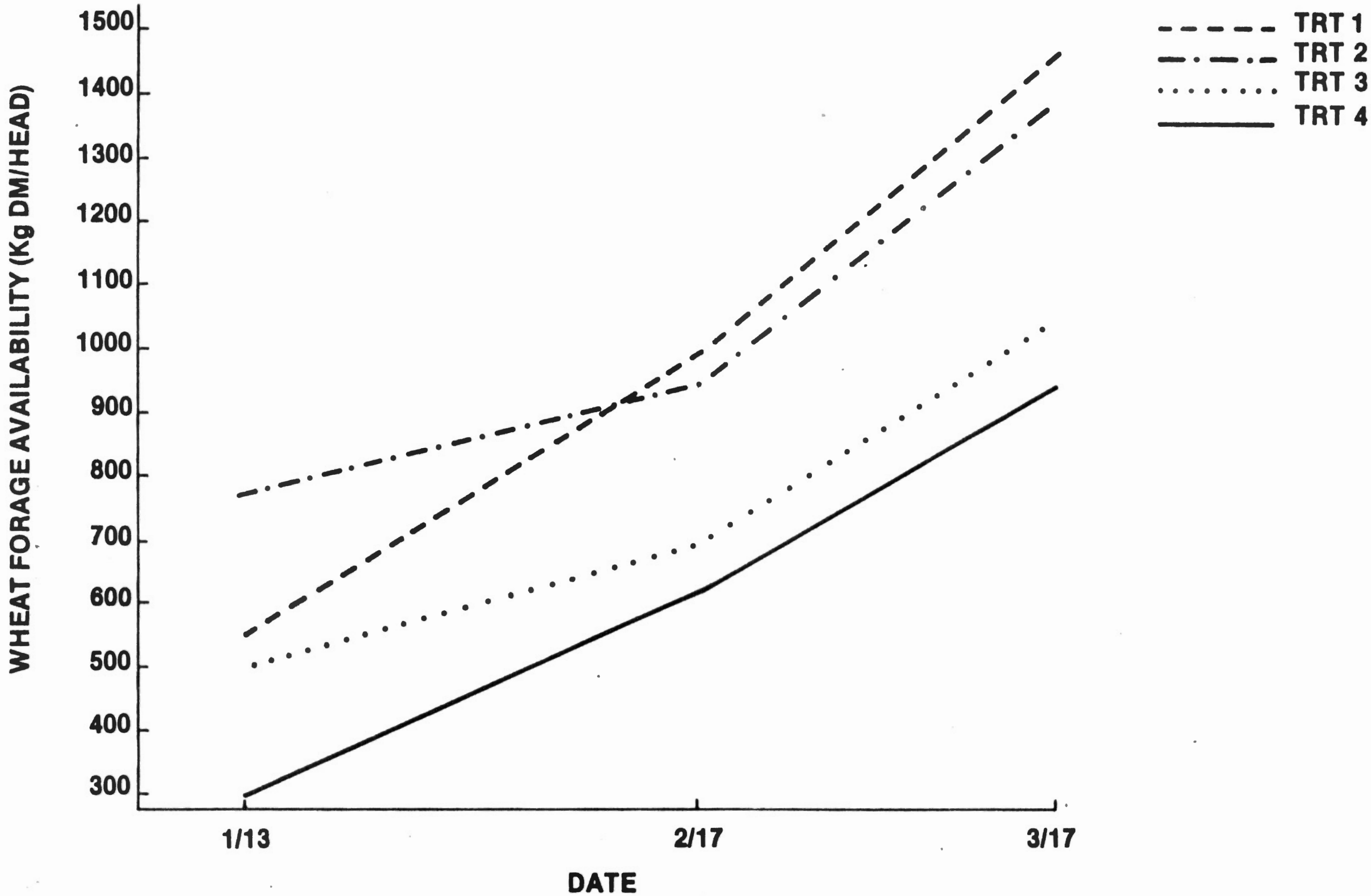

Figure 4. Wheat Forage Availability (kg DM/Steer) on Wheat Pasture Year 2.

TABLE V

SILAGE CONSUMPTION AND AVERAGE DAILY GAINS OF STEERS ON WHEAT PASTURE (YEAR 2 TREATMENT MEANS)

Treatment:		1	2	3	4
Number of Steers:		12	12	12	12
Period	Date				
I	1/13/83-3/17/83(62 days)				
	Silage DM Intake, kg/hd/day	0	1.04	1.15	1.03
	**ADG, kg	0.96	1.17	1.05	1.00
II	3/18/83-5/26/83(70 days)				
	Graze-out* ADG, kg	1.29	1.27	1.28	1.25
III	1/13/83-5/26/83(132 days)				
	ADG, kg	1.13	1.22	1.17	1.13

* Silage was not fed during the graze-out period.

** ADG = Average Daily Gain.

CHAPTER IV

EFFECT OF SILAGE SUPPLEMENTATION OF CATTLE GRAZING WHEAT PASTURE ON INTAKE AND TURNOVER OF WHEAT FORAGE

Summary

Twenty-four steers were used in each of two years to investigate the effects of silage supplementation on wheat forage intake and turnover rate of steers grazing wheat pasture. Ytterbium labled wheat forage was given to steers allotted to one of four treatments with six replications in a completely randome design where silage was fed at levels of 0, 0.35, 0.70 and 1.05 kg DM/100 kg body weight. Fecal grab samples were taken at various time intervals for 96 hours following dosing and analyzed for Yb content. The fecal-Yb excretion curves were fitted to the one-compartment model of Ellis et al. (1979) and estimates of wheat forage intake and turnover rates were obtained. Actual silage consumptions were 0, 0.37, 0.70 and 0.86 kg DM/100 kg BW for treatments 1 to 4, respectively in year 1. In year 1 there was a positive associative effect of a low level of silage supplementation (.35% of BW) on wheat forage intake. Subsequent increases in silage consumption increased total DM consumption over that of steers not fed silage, but decreased wheat forage DM consumption. When silage was offered, steers ate to a constant fill level of about 0.8 kg DM/100 kg body weight. In year 2, actual silage consumptions were 0, 0.32, 0.60

and 0.84 kg DM/100 kg BW for treatments 1 to 4, respectively. Positive associative effects of a small amount of silage on wheat forage intake were not observed. Substitution effects were evident at low to moderate levels of silage supplementation (.35 to .70 % of BW). At a high level of silage supplementation (about 1% of BW) some substitution took place but, total intake was increased. Wheat forage turnover rate in year 1 decreased from 12.55 hours for no silage supplementation to 11.56 hours when .86 % of BW silage DM was comsumped. In year 2 turnover of wheat forage decreased from 21.9 hours for no silage supplementation to 19.0 hours when .84 % of BW silage DM was consumped.

Introduction

Improving the performance of grazing cattle when supplemented with another feed source may be due to increased dry matter consumption, diet digestibility and/or nitrogen utilization in the rumen (Lake et al., 1974a). However, in grazing conditions these parameters are difficult to control and measure. Some researchers have reported that supplementation of grazing animals will increase the overall feed intake of the animal (Allden and Jennings, 1962; Langlands, 1969; Umoh and Holmes, 1974). Other reported research indicates no increase in feed intake (Lake et al., 1974a; Newton and Young, 1974). In nearly all studies reported, the amount of supplemental feed consumed will act as a substitute for some amount of forage in relation to total dietary intake. Gulbransen (1974) reported that the degree of substitution may range from 15 to 90 percent, depending on the forage quality and supplemental feed intake. Feeding high amounts of energy can be expected to depress forage intake if the animal is eating to meet energy needs.

In the ruminant, body pools tend to remain constant in size while undergoing replacement by input equal to output, and this dynamic equilibrium is known as steady state (Shipley and Clark, 1972). Estimating forage intake in the grazing animal is usually calculated from the ratio of fecal excretion of an undigestible marker to the diet digestability (Lake et al., 1974a). Since the ruminant's flow of digesta is considered steady state, intake of forages by the animal can be measured using steady state kinetics as described by Ellis et al., 1979.

The purpose of this study was to investigate the effects of silage supplementation on intake and turnover of wheat forage by wheat pasture stocker cattle. The data reported herein are the results of the first two years of a three year project initiated in the fall of 1981.

Experimental Procedure

Wheat Pasture Year 1

Cattle and Treatments. Twenty-four fall weaned steers (ten Hereford and fourteen Hereford-Angus Crossbred) that weighed 279 ± 17.6 kg were sorted into groups of four based on ranking by weight within breed. Steers within each group were then randomly assigned to one of the following four treatments:

TREATMENT	PASTURE	WHEAT SILAGE
1	Wheat	none
2	Wheat	0.35 kg DM/100 kg body weight
3	Wheat	0.70 kg DM/100 kg body weight
4	Wheat	1.05 kg DM/100 kg body weight

Adaptation and Collection Periods. The trial was conducted from February 19 to March 6, 1982. Steers were adapted to silage from February 19 to March 1 (10 days). Silage was fed to steers in individual stalls at approximately 0830 hours and steers were allowed access to wheat pasture after consuming silage. At dusk (approx. 1900 hours) all cattle were drylotted until silage was fed the following morning. Daily consumptin of silage were recorded. During the collection period (March 2-6), steers were treated similarly as in the adaptation period with these differences: 1) On March 2 all steers were fed approximately 170 g of ytterbium-labled wheat forage dry matter (5502 ug Yb/gDM) with their silage. If steers failed to consume the labled forage, a small amount of dehydrated alfalfa meal was added;and if steers still rejected the forage, it was force fed using gelatin capsules. The forage was labled using 5g of Ytterbium Chloride ($YbCl_2$) in the immersion technique as described by Teeter et al. (1984) and Mader et al. (1984), 2) Fecal grab samples were collected from each steer at 0,4,8,12,24,28, 32,36,48,56,72,80,96 and 104 hours after feeding the Yb-labled forage, 3) Silage and hand-clipped samples of forage were collected daily and 4) All steers were weighed at the conclusion of the trial after an overnight stand without feed or water.

Analytical Procedures. All samples collected were dried in forced-air ovens (65 C). The silage samples were pooled across days of the collection period, as were the hand-clipped forage samples, and analyzed for in vitro dry matter digestability (IVDMD) as described by Tilley and Terry (1963) and for crude protein (CP) using the macro-Kjeldhal procedure (AOAC., 1975). Each fecal sample and ytterbium labled forage sample was ground through a 2mm-mesh screen of a Wiley Mill grinder and a 2g sample was ashed (8 hours @ 500 C). The fecal ash was then dissolved in 3 normal nitric-hydrochloric acid solution (3N HNO :3N HCl = 1:1 on a v:v basis) and diluted with a 10 percent hydrochloric acid solution with 1000ug K+ per liter. Ytterbium concentration was then measured by atomic absorption spectroscopy. Standards were made by ashing 2g of 0-time feces, dissolving in 3N HNO HCl solution, adding Yb working standard solution and diluting with a 10% HCl solution. 0-time fecal ash was used to correct for interferences.

Calcualtions. Fecal Yb concentrations were fitted to the one-compartment model of Ellis et al. (1979).

$$Y = K_0 * T * K_1^2 * e^{-k_1 T}$$

Where: Y = Fecal Yb concentration, K_0 = Initial concentration of marker in the compartment, T = Hours post dosage minus time delay and K_1 = Time-dependent rate constant.

These values were used to calculate the following variables:

Total Fecal Output (TFO), kg/day = (Yb Dosage $\div$ K_0) * 24

Wheat Forage FO, kg/day =
TFO -- [Silage DM Intake * (1 -- Silage IVDMD)]

Wheat Forage DM Intake, kg/day =
Wheat Forage FO $\div$ (1 -- Wheat Forage IVDMD)

Flow, %/hour = K_1 * .59635

Turnover, hours = 1 $\div$ Flow

$$\text{Fill, kg} = \text{Yb Dosage} \div (K_0 * K_1 * .59635)$$

$$\text{Outflow, kg/day} = \text{Fill} * \text{Flow} * 24$$

Flow of wheat forage was also measured based upon the slope of the descending portion of the fecal Yb excretion curve of log Yb vs Time.

Statistical Analysis. All data were statistically analyzed using the General Linear Models Procedure (GLM) of the Statistical Analysis System based on a completely random experimental design. Duncan's Multiple Range Tests were used to analyze treatment means for the following variables: Silage dry matter intakes, turnover and flow of wheat forage, fill and outflow of the undigested dry matter of the gastro-intestinal tract, wheat forage and total forage dry matter intakes. Orthogonal contrasts (trends) of linear and quadratic effects were also performed on flow, fill, turnover, outflow, wheat forage intake and total forage intake.

Wheat Pasture Year 2

Cattle and Treatments. Twenty-four fall-weaned steers (20 Hereford and 4 Hereford x Angus Crossbred) that weighed 230 ± 38.2 kg were sorted into groups of four based on ranking by weight within breed. Steers within each group were then randomly assigned to one of the four treatments as described in "Wheat Pasture Year 1" with this difference: Sorghum silage was used in place of wheat silage.

Adaptation and Collection Periods. The trial was conducted from March 4 to March 25, 1983. Steers were adapted to silage from March 4-21. The collection period was from March 22-25. Cattle were cared for as described in year 1 for both the adaptation and collection periods with the followin differences: 1) Cattle were drylotted at approx. 1830 hours, 2) Yb-labled forage was fed March 22 (approx. 210g of forage DM @ 9007ug Yb/g of forage DM) and 3) A sixteen hour fecal sample was collected and the 96 and 104 hour fecal samples were omitted during the collection period.

Analytical Procedures. All samples in this trial were analyzed as described in year 1.

Calculations. Calculations were made as in year 1. In addition, appendix table XIII presents calculations from the two-compartment time dependent-time independent model of Ellis et al. (1979) for the variables measured in year 2. In both years (1 & 2), the one compartment model of Ellis et al. (1979) was used. In year 1 the two compartment model resulted in extremely high standard errors for K_0, K_1, K_2 and tau. In year 2 the addition of a 16 hour fecal sample helped to decrease errors, however, the one compartment model still had lower error terms.

Statistical Analysis. All data were statistically analyzed as in year 1.

Results and Discussion

Silage and wheat forage composition for years 1 and 2 are presented in appendix table IX. Thus, these analyses will not be discussed here.

Wheat Pasture Year 1

Forage DM intakes expressed as a percent of body weight are shown in figure 5. Treatment means are presented in appendix table X. Silage dry-matter consumption of steers of treatments 2,3 and 4 were

0.37, 0.70 and 0.86 percent of body weight, respectively. Consumption of silage by steers of treatment 4 was 0.19 percent of body weight less than anticipated. Wheat forage intake and total forage intake of steers fed the lowest level of silage (treatment 2) were increased indicating a positive associative effect of a small amount of silage on wheat forage intake. Wheat and total forage intake decreased with further increases (treatments 3 and 4) in silage intake. However, steers of treatments 3 and 4 still consumed more total forage than those steers of treatment 1.

Flow (%/hour) and turnover (hours) of wheat forage and fill (kg) and outflow (kg/day) of the total gastro-intestinal tract are shown in figure 6. Flow and turnover of wheat forage of steers in treatment 3 had extremely large fluctuations and did not fit known biological phenomenon, therefore, they were deleted when calculating the effects of silage intake on trends of flow and turnover of wheat forage. Deletion of treatment 3 still left three points for examining trends. Treatment means with treatment 3 deleted are shown in appendix table XI. Flow of wheat forage increased with increasing silage intake from 8.1 %/h (trt 1) to 9.0 %/h (trt 4). This increase was small and one would not expect to see differences in the utilization of wheat forage amoung treatments. Turnover, the recipricol of flow, of wheat forage decreased from 12.55 hours (trt 1) to 11.57 hours (trt 4). Fill and outflow tended to increase when steers increased their intakes of silage. The increased outflow reached a plateau of 2.2 kg per day (or about .8% BW) at treatment 2 and appeared to limit wheat forage and total forage intake of steers of treatments 3 and 4.

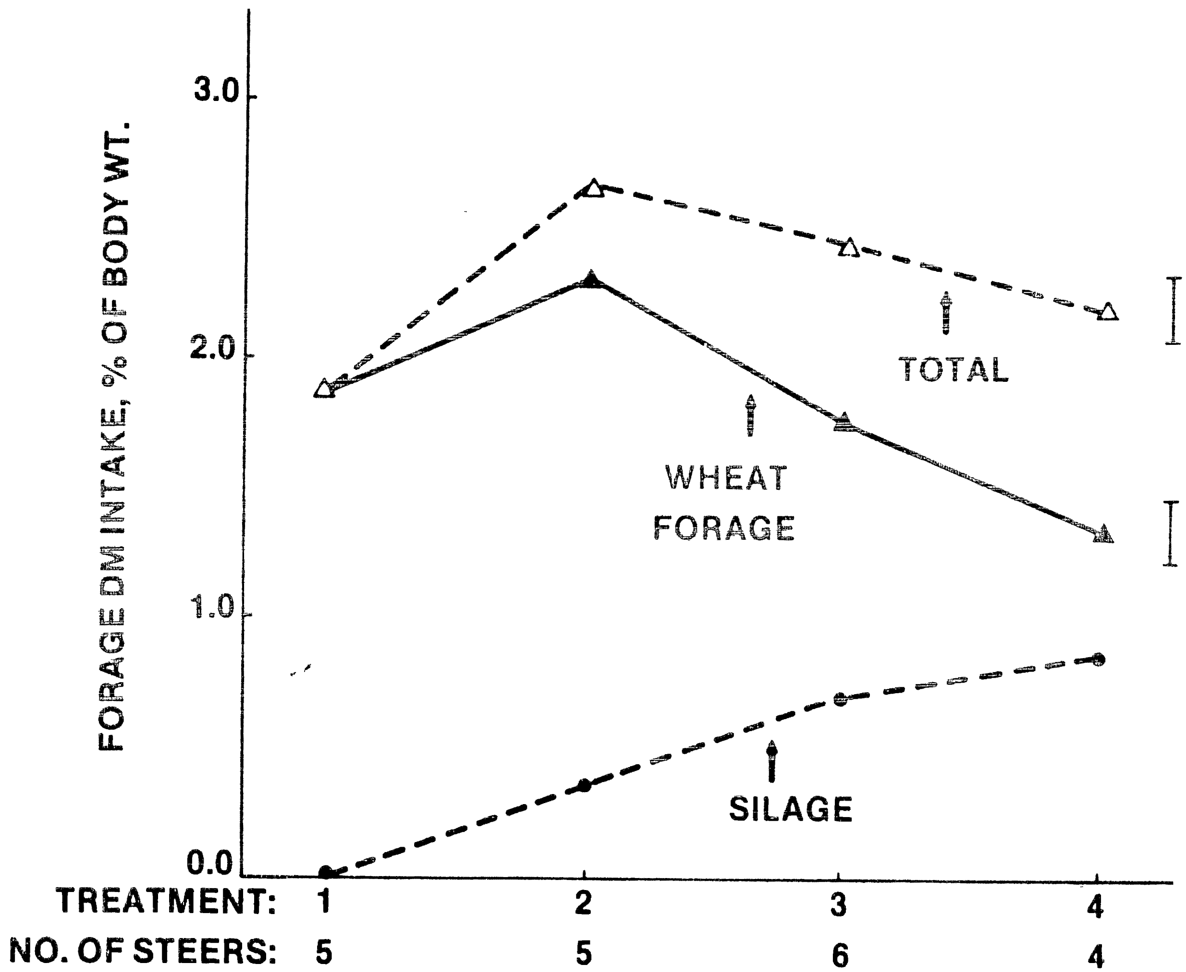

Figure 5. Forage DM Intake of Steers vs Treatment (Year 1).

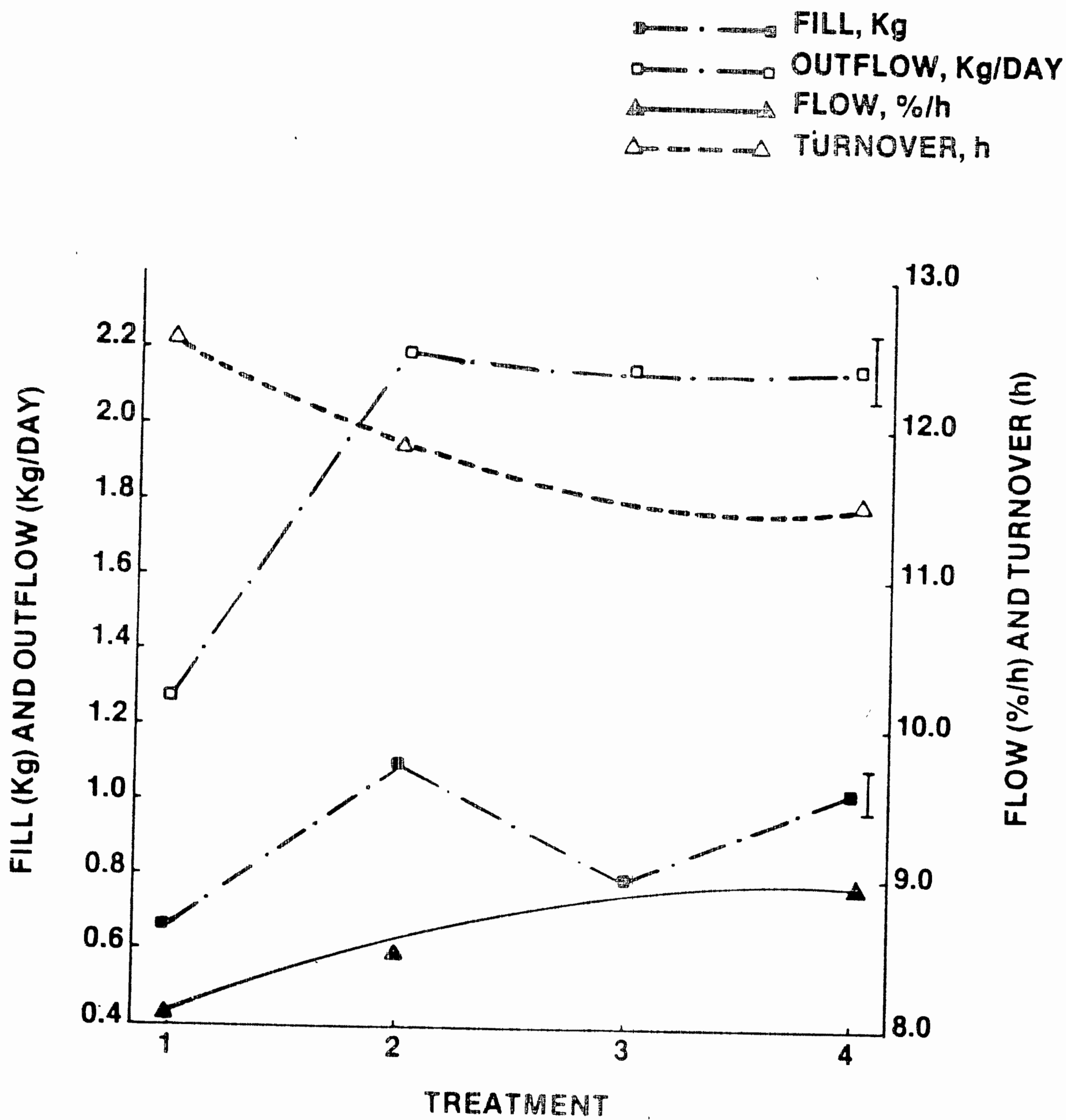

Figure 6. Fill and Outflow of Gastrointestinal Tract Contents and Flow and Turnover of Wheat Forage vs Treatment (Year 1).

Wheat Pasture Year 2

Forage drymatter intakes expressed as a percent of body weight are shown in figure 8. Treatment means are presented in appendix table XII. Silage drymatter intakes of steers of treatments 2,3 and 4 were 0.32, 0.60 and 0.84 percent of body weight, respectively. As silage dry matter consumption increased wheat forage intake tended to decrease with the exception of treatment 4. Total forage dry matter intake was maintained at a level of about 3% of body weight for treatments 1, 2 and 3. Total dry matter intake of steers of treatment 4 increased at a high level of silage intake. It appeared that for treatments 2 and 3, when silage was offered the steers tended to substitute silage dry matter consumed for wheat forage dry matter consumed when compared to treatment 1 steers. Treatment 4 steers tended to show only a slight substitution effect on wheat forage dry matter intake at a high level of silage intake.

Flow (%/hour) and turnover (hours) of wheat forage and fill (kg) and outflow (kg/day) of the total gastro-intestinal tract are shown in figure 8. In the trend analyses, all four of these variables exhibited a linear movement from treatment 1 to treatment 4. Although flow of wheat forage increased from 4.6 to 5.3 %/hour from treatments 1 to 4, respectively, this increase was small and as in year 1. However, turnover of wheat forage tended to decrease from 21.9 to 19.0 hours from treatments 1 to 4, respectively. With fill and outflow increasing with increasing silage dry-matter intake and wheat forage turnover rate decreasing, one would expect to observe steers consuming more total dry-matter. This phenomenon was only seen for steers of treatment 4.

When silage was supplemented to steers grazing wheat pasture, a trend toward increasing the fill and outflow of total gastrointestinal tract contents was noted for each year. It appeared that steers consumed wheat forage and silage dry matter until outflow of total gastrointestinal tract contents reached a level of about 0.8 percent of body weight. Silage supplementation to wheat pasture stocker cattle may not have increased dietary dry matter consumption nor maintained gains in periods of low forage availability, however, it did allow for increased carrying capacity (stocking rate) and total amount of beef produced per unit of land area.

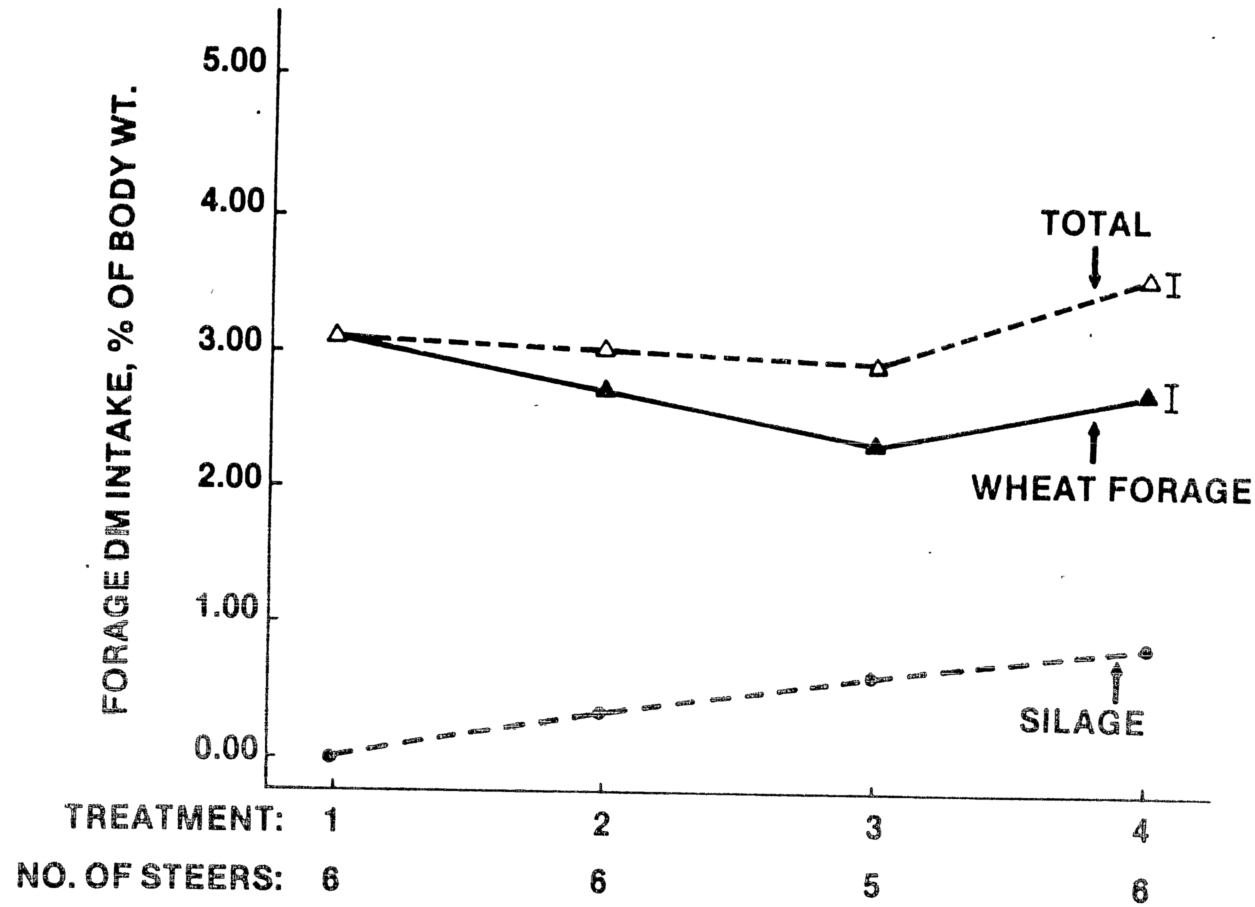

Figure 7. Forage DM Intake of Steers vs Treatment (Year 2).

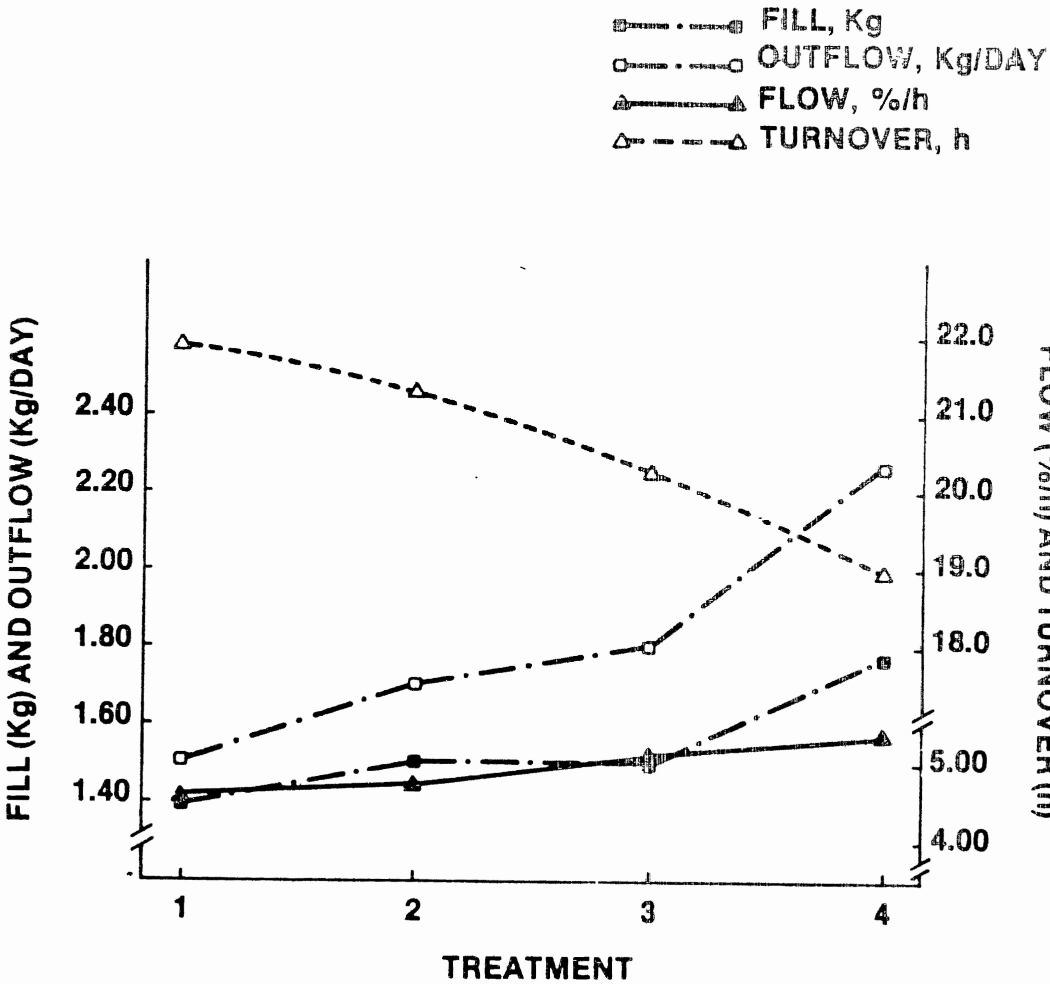

Figure 8. Fill and Outflow of Gastrointestinal Tract Contents and Flow and Turnover of Wheat Forage vs Treatment (Year 2).

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TABLE VI

SILAGE COMPOSITION (GRAZING TRIAL YEARS 1 & 2)

	CP*	IVDMD*	DM*
Wheat Silage (Year 1):		%	
December 1981	9.48	50.62	35.10
January 1982	9.15	51.23	36.75
February 1982	9.07	51.00	33.18
March 1982	9.09	51.00	35.94
Mean Year 1	9.20	50.96	35.24
SEM	.096	.126	.766
Sorghum Silage (Year 2):			
January 1983	9.42	51.30	28.85
February 1983	7.99	54.65	25.62
March 1983	8.51	53.42	28.63
Mean Year 2	8.64	53.12	27.70
SEM	.412	.978	1.042

* CP = Crude Protein; IVDMD = In vitro dry matter digestibility; DM = Dry Matter.

All values expressed as a percentage of dry matter.

TABLE VII

WHEAT FORAGE AVAILABILITIES AND COMPOSITION
(GRAZING TRIAL YEAR 1)

Date		Availability		*CP	*IVDMD	*DM
		kg DM/head	kg DM/ hectare	%		
December 23, 1981						
Treatment	1	1205	1465	26.62	78.63	25.48
	2	1355	1387	28.03	81.00	23.97
	3	869	1236	26.47	79.30	24.61
	4	479	1335	26.30	80.57	24.28
January 25, 1982						
Treatment	1	493	607	22.12	76.24	42.87
	2	470	479	23.32	75.70	41.43
	3	254	364	20.87	72.34	42.72
	4	48	134	21.68	72.84	41.77
March 1, 1982						
Treatment	1	255	305	25.57	72.50	27.91
	2	499	515	28.57	74.23	27.57
	3	125	176	25.33	66.93	28.96
	4	45	123	27.74	69.63	24.81
March 24, 1982						
Treatment	1	737	895	24.71	72.07	20.59
	2	1131	1140	26.44	71.04	18.88
	3	397	566	27.13	71.70	18.25
	4	126	357	27.63	73.40	18.34

*CP = Crude Protein; IVDMD = In Vitro Dry Matter Digestibility; DM = Dry Matter.

All values expressed as a percentage of dry matter.

TABLE VIII

WHEAT FORAGE AVAILABILITIES AND COMPOSITION
(GRAZING TRIAL YEAR 2)

Date	Availability		*CP	*IVDMD	*DM
	kg DM/head	kg DM/ hectare	%		
January 13, 1983					
Treatment 1	545	437	N.A.	N.A.	N.A.
2	764	755	N.A.	N.A.	N.A.
3	493	522	N.A.	N.A.	N.A.
4	288	305	N.A.	N.A.	N.A.
February 17, 1983					
Treatment 1	1012	811	23.21	72.87	33.10
2	938	927	26.11	74.86	29.75
3	698	900	27.19	73.65	28.96
4	623	659	22.50	72.50	33.46
March 17, 1983					
Treatment 1	1482	1187	28.77	75.87	20.17
2	1388	1372	30.93	74.43	19.36
3	1060	1366	29.91	74.22	19.23
4	960	1017	27.82	76.48	22.28

* CP = Crude Protein; IVDMD = In Vitro Dry Matter Digestibility; DM = Dry Matter.

All values expressed as a percentage of dry matter.

TABLE IX

SILAGE AND FORAGE COMPOSITION DURING INTAKE TRIALS (YEARS 1 & 2)

Item		*CP	*IVDMD	*DM
		%		
Year 1:	Wheat Silage	9.44	50.73	36.68
	Wheat Forage	27.25	74.90	25.80
Year 2:	Sorghum Silage	7.73	56.38	27.92
	Wheat Forage	30.19	77.80	16.13

* CP = Crude Protein; IVDMD = In Vitro Dry Matter Digestibility; DM = Dry Matter.

All values expressed as a percentage of dry matter.

TABLE X

INTAKE AND TURNOVER OF WHEAT FORAGE
TREATMENT MEANS (YEAR 1)

Variable	Treatment 1	Treatment 2	Treatment 3	Treatment 4	*O.S.L. of Trends Linear	*O.S.L. of Trends Quadratic	SEM
Number of Steers	5	5	6	4			
Steer Weight, kg	269.6^{A}	288.4^{A}	274.6^{A}	287.5^{A}			7.28
Silage DM Intake, %BW	0^{A}	0.37^{B}	0.70^{C}	0.86^{C}			.012
Wheat Forage DM Intake, %BW	1.87^{AB}	2.30^{A}	1.75^{AB}	1.34^{B}	.083	.114	.248
Total Forage DM Intake, %BW	1.87^{A}	2.67^{A}	2.46^{A}	2.20^{A}	.509	.050	.244
Flow, %/hour	8.12^{B}	8.53^{B}	11.28^{A}	8.99^{B}	.071	.038	.590
Turnover, hours	12.55^{A}	11.88^{A}	8.92^{A}	11.57^{A}	.129	.054	.787
Fill, kg	0.66^{A}	1.11^{B}	0.81^{AB}	1.06^{B}	.139	.450	.123
Outflow, kg/day	1.28^{A}	2.20^{A}	2.16^{A}	2.18^{A}	.009	.034	.194
Outflow, % of BW	0.47	0.76	0.79	0.76			.355
Flow From Declining Slope of log Yb, %/hour	6.45^{A}	6.44^{A}	7.30^{AB}	7.94^{B}			

*O.S.L. = Observed Significant levels.

^{ABCD}Means in the same row with common superscripts are not different (P>.05).

TABLE XI

INTAKE AND TURNOVER OF WHEAT FORAGE TREATMENT MEANS WITH TREATMENT 3 DELETED (YEAR 1).

Variable	Treatment 1	Treatment 2	Treatment 4	*OSL of Trends Linear	*OSL of Trends Quadratic	SEM
Number of Steers	5	5	4			
Steer Weight, kg	269.6	288.4	287.5			
Silage DM Intake, %BW	0	0.37	0.86	.001	.867	.012
Wheat Forage DM Intake, %BW	1.87	2.30	1.34	.128	.038	.222
Total Forage DM Intake, %BW	1.87	2.67	2.20	.354	.035	.218
Flow, %/hour	8.12	8.53	8.99	.388	.964	.649
Turnover, hours	12.55	11.88	11.57	.492	.837	.921
Fill, kg	0.66	1.11	1.06	.076	.131	.134
Outflow, kg/day	1.28	2.20	2.18	.006	.035	.178

*OSL = observed signif. levels.

TABLE XII

INTAKE AND TURNOVER OF WHEAT FORAGE
TREATMENT MEANS (YEAR 2)

Variable	Treatment 1	Treatment 2	Treatment 3	Treatment 4	*O.S.L. of Trends: Linear	*O.S.L. of Trends: Quadratic	SEM
Number of Steers	6	6	5	6			
Steer Weight, kg	225.8^{A}	229.0^{A}	233.1^{A}	231.5^{A}			7.49
Silage DM Intake, %BW	0^{A}	0.32^{B}	0.60^{C}	0.84^{D}			.031
Wheat Forage DM Intake, %BW	3.09^{A}	2.71^{AB}	2.32^{B}	2.73^{AB}	.084	.042	.177
Total Forage DM Intake, %BW	3.09^{AB}	3.03^{AB}	2.92^{A}	3.58^{B}	.100	.063	.175
Flow, %/hour	4.60^{A}	4.71^{A}	5.07^{A}	5.33^{A}	.026	.767	.237
Turnover, hours	21.9^{A}	21.3^{A}	20.2^{A}	19.0^{A}	.048	.756	1.05
Fill, kg	1.41^{A}	1.51^{AB}	1.51^{AB}	1.78^{B}	.016	.394	.093
Outflow, kg/day	1.55^{A}	1.70^{A}	1.81^{A}	2.27^{B}	.001	.228	.120
Outflow, % of body wt.	0.69	0.74	0.78	0.98			
Flow From Declining Slope of log Yb, %/hour	6.22^{A}	6.18^{A}	7.51^{B}	7.43^{B}			.405

*O.S.L. = Observed Significant Levels.

^{ABCD}Means in the same row with common superscripts are not different (P>.05).

TABLE XIII

INTAKE AND TURNOVER OF WHEAT FORAGE TREATMENT MEANS
BASED ON THE *TWO-COMPARTMENT MODEL (YEAR 2)

	Treatment				**O.S.L. of Trends		
	1	2	3	4	Linear	Quadratic	SEM
Number of Steers	6	6	5	6			
Steer Weight, kg	225.8^{A}	229.0^{A}	234.3^{A}	231.5^{A}			7.66
Silage DM Intake, %BW	0^{A}	0.32^{B}	0.60^{C}	0.84^{D}			.031
Wheat Forage DM Intake, %BW	3.13^{A}	2.85^{AB}	2.41^{AB}	2.76^{AB}	.088	.122	.191
Total Forage DM Intake, %BW	3.13^{A}	3.17^{A}	3.02^{A}	3.61^{A}	.143	.166	.186
Flow, %/hour	6.97^{A}	8.80^{AB}	10.73^{B}	11.89^{B}	.003	.774	1.11
Turnover, hours	15.8^{A}	12.9^{AB}	10.1^{B}	8.6^{B}	.004	.686	1.64
Fill, kg	1.02^{A}	0.94^{A}	0.80^{A}	0.81^{A}	.170	.702	.119
Outflow, kg/day	1.58^{A}	1.77^{A}	1.86^{A}	2.28^{B}	.001	.378	.122

* Two-Compartment Time Dependent-Time Independent Model of Ellis et al. (1979).
** O.S.L. = Observed Significant Levels.
^{ABCD}Means in the same row with a common superscript are not different (P>.05).

2

VITA

Michael Joseph Ford

Candidate for the Degree of

Master of Science

Thesis: SUPPLEMENTATION OF WHEAT PASTURE STOCKER CATTLE WITH SILAGE.

Major Field: Animal Science

Biographical:

Personal Data: Born in Indianapolis, Indiana, July 25, 1959. The son of Harold and Karen Ford. Married Amy Ann Dunnichay, August 4, 1978.

Education: Graduated from New Palestine High School, New Palestine, Indiana, in May, 1977; received the Bachelor of Science degree in Animal Science from Purdue University, West Lafayette, Indiana, in December, 1981; completed the requirements for the Master of Science degree in Animal Science at Oklahoma State University, Stillwater, Oklahoma, in May, 1984.

Professional Experience: Worked on a dairy in central Indiana, 1971-1978; raised swine breeding stock in central Indiana, 1979-1981; completed three years in a cooperative education program in farm animal research with Eli Lilly & Co., 1979-1981; Graduate Assistant at Oklahoma State University, 1982-1984.

Professional Organizations: American Soceity of Animal Science.